Appl. No. 10/812,943
Amdt. Dated March 16, 2007
Reply to Office Action of October 19, 2006

Amendments to the Drawings:

The attached sheets of drawings include changes to Figures 1, 2A, 2B and 5. The sheets containing Figures 1, 2A, 2B and 5 replace the original sheets containing Figures 1, 2A, 2B and 5. Figures 1, 2A and 2B have been amended to show the cooling chamber, identified by reference numeral 24, and the coolant gas intake by reference numeral 25. Figure 5 has been amended to show cutting wheel blade 15 more accurately.

Attachment: Replacement Sheets
Annotated Sheets Showing Changes

REMARKS/ARGUMENTS

In the Office Action mailed on October 19, 2006, the Examiner has maintained the objection to the restriction/election requirement mailed on June 30, 2006, and has withdrawn Claims 1 to 41 and 45 to 54 from consideration in this application.

Applicant reserves the right to present any of the withdrawn claims in one or more divisional application.

In relation to the application as comprising the remaining Claims 42 to 44, the Examiner has raised objections to the drawings, a formality objection to Claim 43, an objection under 35 USC § 112 to Claims 42 to 44, an anticipation objection to Claim 42, and obviousness objections to Claims 43 and 44.

Applicant has amended the drawings and the claims, and respectfully submits that each of the Examiner's objections has been overcome, for the reasons which are discussed below in the order raised by the Examiner.

In the Specification

Applicant has amended para. [0037] to provide a reference numeral for the cooling chamber and coolant gas intake, to replace "not shown" by "24, served by coolant gas intake 25", to correspond to the amendment to the drawings, as noted below.

Applicant has also amended para. [0040] to correct a typographical error.

In the Drawings

The Examiner has required that the cooling chamber be shown in the drawings, or the feature cancelled from the claims. Applicant has amended Figures 1, 2A and 2B to show the cooling chamber, identified in each of these three drawings by reference numeral 24, and the coolant gas intake by reference numeral 25. Applicant has amended the Specification accordingly, as noted above.

In the Claims

Objection to Claim 43

The Examiner has objected to the word "adapted" in the phrase "a cutting means adapted to render pellets from ..." In the amended claims submitted herewith, Applicant has amended the phrase to read "a cutting means for rendering pellets from ..."

Objection under 35 USC § 112 to Claims 42 to 44

The Examiner has objected to each of Claims 42 to 44 as allegedly being indefinite, citing an alleged lack of antecedents for the term "the sprayer nozzles" based on the feature of sprayer nozzles having been introduced into Claim 42 as "at least one sprayer nozzle". Applicant respectfully submits that the term "the sprayer nozzles" does not appear in either of Claims 43 or 44. Applicant has amended Claim 42 to replace the introduction of this feature "at least one nozzle" by the term "at least one sprayer nozzle", and to amend each reference to "the sprayer nozzles" to read "each of the at least one sprayer nozzle".

Rejection of Claim 42 under 35 USC § 102 as anticipated by DE 3538014 A1

The Examiner has cited this reference as allegedly disclosing each of the features of Claim 42, based on Figures 6 and 7 and the English translation of the Abstract of the reference.

Applicant respectfully submits that Figures 6 and 7, together with the Abstract as translated, do not teach each of the features of Claim 42. In particular, the Examiner appears to be relying on an identification of feature 12 in the drawings of the reference as showing spray nozzles for spraying a molten polymer stream. Applicant respectfully submits that the Abstract does not in fact show or suggest that this feature is in fact a nozzle intended for or capable of spraying molten polymer, much less one for spraying the polymer and thereby spreading apart the wires in a bundle.

However, for greater certainty, Applicant has obtained an English translation of the complete published application, and respectfully submits that a review of the document, and

the accurate translation of the Abstract as published, shows that each feature identified in the reference as 12 is indeed not a spray nozzle intended for, or capable of, spreading fibers of a roving and delivering molten polymer to them, but is a heat gun for heating precoated bundled wires, to effect repairs to an outer coating of the bundle.

Applicant encloses herewith, for the assistance of the Examiner, a copy of the English translation of the cited reference.

From this complete version, Applicant submits that the reference is directed to applying a heat source to
(1) melt thermoplastic coatings already applied to the outer surface of individual strands of a bundle, so as to set the bundle; and
(2) apply, with heat, an outer thermoplastic coating to the completed bundle.

However, the embodiment shown in Figure 7 relates only to a repair process, i.e. an on-site performing of step (2) above.

There is absolutely nothing anywhere in the reference to suggest any other use of the nozzles 12 or the flame-spray guns 11 than to apply heat, nor any additional nozzles apart from 12 and 11; much less is there any teaching in the reference of the application of a stream of molten polymer.

Further, as the step which occurs in the region depicted in Figure 7 of the reference is the melting of the coating (previously applied) on the individual wires in the bundles, and the application of the outer coat, spreading the wires out would be entirely counterproductive/destructive; and as no new polymer material is being added at that stage between the individual wires, there would of course be no reason to spread them out.

In addition, the teachings of the reference are primarily directed at providing an anti-corrosion feature for large load-bearing bundles of wires, primarily intended for large scale

civil engineering projects and installations such as suspension bridges, masts and offshore structures. The teachings are expressly stated as relating to the application of protection either at the point of installation or as a subsequent on-site repair operation.

The Examiner is referred in particular to section II of the Description of the reference, on page 5, which explains the features by reference to Claim 1, which itself clearly identifies the nature of, and steps in, the on-site operation of the corrosion protection method of the reference.

The Examiner is further referred to page 11 of the reference, where the reference numbers are listed, and identify feature 11 as "flame-spray guns" and feature 12 as "guns only for heating the PDB and PLB2 revolving mounts..." Further, on page 12, Figure 7 is identified as depicting a "longitudinal section through a mobile coating cage which is fed by a small projecting support structure attached to the upper pylon end and moved lengthwise from there on the PDB by rollers, whereby the coating of an inclined cable in need of repair takes place".

In contrast, the teachings of the present reference are directed to spreading fibers in a strand, where the fibers are of extremely small dimensions, as is clear from the Specification. For example, the preferred size of the nozzle orifices is less than 0.35mm (see para. [0044]). It cannot be said that the teachings of the cited reference of a method of repairing an outer coating of a load-bearing installed cable on a suspension bridge disclose the features of using a stream of molten polymer from a spray nozzle to forcibly spread apart the individual tiny fibers of a bundle, without rubbing them against any solid surface, in order to apply the polymer to them to form, after cooling, the set unit.

As the Examiner notes, the cooling process in the reference is water-based. There is no teaching of cooling by gas.

Applicant respectfully submits that the features shown in Figure 7 are clearly incapable of being used for the purposes of the present invention, and that none of Figure 6, Figure 7 or the Abstract (particularly as accurately translated in the translation submitted herewith) alone or in combination teaches the spraying a molten polymer coating onto a roving so as to spread the wires within the roving, and thereby apply the molten polymer coating to each individual wire, followed by cooling the coated wires to form the single contiguous polymer coated bundle.

Applicant therefore respectfully submits that DE 3538014 A1 cannot be regarded as anticipating claim 42, and respectfully requests that the citation of DE 3538014 A1 be withdrawn.

Rejection of Claim 43 under 35 USC § 103(a) based on DE 3538014 A1 in view of US 5,525,423 to Liberman et al.

The Examiner has stated that DE 3538014 A1 lacks a cutting means, whereas Figure 10 of Liberman et al. disclose a cutting means (184) to render pellets. Applicant respectfully submits that Liberman et al. disclose a cutter 184 for an extruded composite material 160, and that the reference cannot be combined with the teachings of DE 3538014 A1 to lead to the present invention, for the following reasons.

Firstly, as discussed above, the reference DE 3538014 A1 does not teach all of the features of Claim 42, in that, inter alia, it fails to teach sprayer nozzles for delivering a molten polymer stream capable of spreading the fibers of the roving. There is no suggestion that any of the features of Claim 42 which are not taught in DE 3538014 A1 are taught by the Liberman et al. reference.

Secondly, in reliance on the authority of In re Rouffet, 149 F. 3d 1350 at 1355, Applicant submits that it is well established that "when a rejection depends on a combination of prior art references, there must be some teaching, suggestion, or motivation to combine the

references"; and as noted by the US Court of Appeals for the Federal Circuit in Re Fulton and Huang, "the prior art as a whole must suggest the desirability of the combination".

Applicant respectfully submits that once the actual teachings of the DE 3538014 A1 reference are discerned from the complete translation of the reference, the "motivation to combine" test is clearly not met in this case. There would be no motivation to combine the teachings of DE 3538014 A1, which are directed to providing anti-corrosive coatings to load-bearing cables for civil engineering installations such as suspension bridges, specifically for on-site repair with a cutter for an extruded material comprised of drawn metallic conducted slivers having a typical diameter of 4 microns (see Column 4, lines 24,2 5 of the Liberman et al. reference). Still further, even if the person skilled in the art was motivated to combine the teachings of these two references, that person would not be led to the present invention.

For these reasons, Claim 43 cannot be regarded as obvious over these two cited references.

Rejection of Claim 44 under 35 USC § 103(a) based on DE 3538014 A1 in view of JP51-43446 or US 4,117,582 to Borelly

The Examiner has stated that the DE 3538014 A1 reference discloses a set of pick-up wheels (item 23 after the cooling chamber in Figure 7). However, the translation of the reference shows that item 23 is "group of three teflon-coated bearing pulleys" (see page 11); i.e. these are rollers which facilitate movement of the coating cage without damaging the cable, and do not "pick-up" or wind anything. They are spring loaded by the springs 26, whose function is identified on page 12 of the English translation of the reference. These clearly cannot be regarded as a reel means on which anything, much less a roving, is wound and retained, or as a supply reel from which anything is or could be unwound.

The Examiner states that the translated abstract and Figure 1 of the JP reference discloses a bobbin (1) on which the roving (2) is wound. Applicant respectfully submits that the

Abstract refers to "feeding wires from a supply bobbin" for a corrugation operation, and that reference numeral 1 simply identifies a supply bobbin for a single wire 2.

The Examiner further states that Borelly in Figure 14 discloses a bobbin (drum 1) on which the roving (band 44) is wound. However, Applicant respectfully submits that the description of Figure 14 of this reference, particularly at Column 16, lines 4 to 17, merely shows that a flat sheet of steel (band 44) is provided from a drum reel, and bent by rollers into a desired shape to be applied to enclose a compressed wire strand.

From these references, the Examiner states that it would have been obvious to include a bobbin in DE 3538014 A1 to supply the fiber or wire materials towards the processing chamber.

Applicant respectfully submits that the "processing chamber" of the DE 3538014 A1 reference is not a chamber through which anything moves after being unwound from a supply means, or indeed at all; i.e there is no movement of wire materials into and out of the chamber which would suggest the use of any type of reel means at the area on the left side of the chamber. Instead, the chamber is moved by a system including pulleys along the finished load bearing cable, in order to effect on-site repairs on the exterior of the cable.

Applicant further submits that, in applying the "motivation to combine" element of the test for obviousness, as discussed above, there would clearly be no motivation to combine the teachings of the DE 3538014 A1 reference, when properly understood as directed to load bearing cables in large scale civil engineering installations, with the teachings of the other cited references, as to providing a drum reel means for supplying a wire or similar material capable of being continuously wound on such drum reel.

Further, it would clearly be impossible to do so; much less thereby to arrive at the present invention. As discussed above, the reference DE 3538014 A1 does not teach all of the features of Claim 42, in that, inter alia, it fails to teach sprayer nozzles for delivering a

molten polymer stream capable of spreading the fibers of the roving. There is no suggestion that any of the features of Claim 42 which are not taught in DE 3538014 A1 are taught by either the JP reference or the Borelly reference.

For the above reasons, Applicant respectfully submits that Claim 44 cannot be regarded as obvious in view of these three cited references.

Conclusion

Applicant respectfully submits that all the Examiner's objections have been overcome, and that the application is now in condition for allowance in relation to amended Claims 42 to 44 as submitted herewith. We look forward to receiving early confirmation of the same.

A request for a two month extension of time is enclosed herewith.

Should any further fees or payments be necessary for entry of this amendment and further prosecution of this application, the undersigned hereby authorizes the Commissioner to debit and/or credit our Deposit Account No. 16-0600.

Respectfully Submitted,
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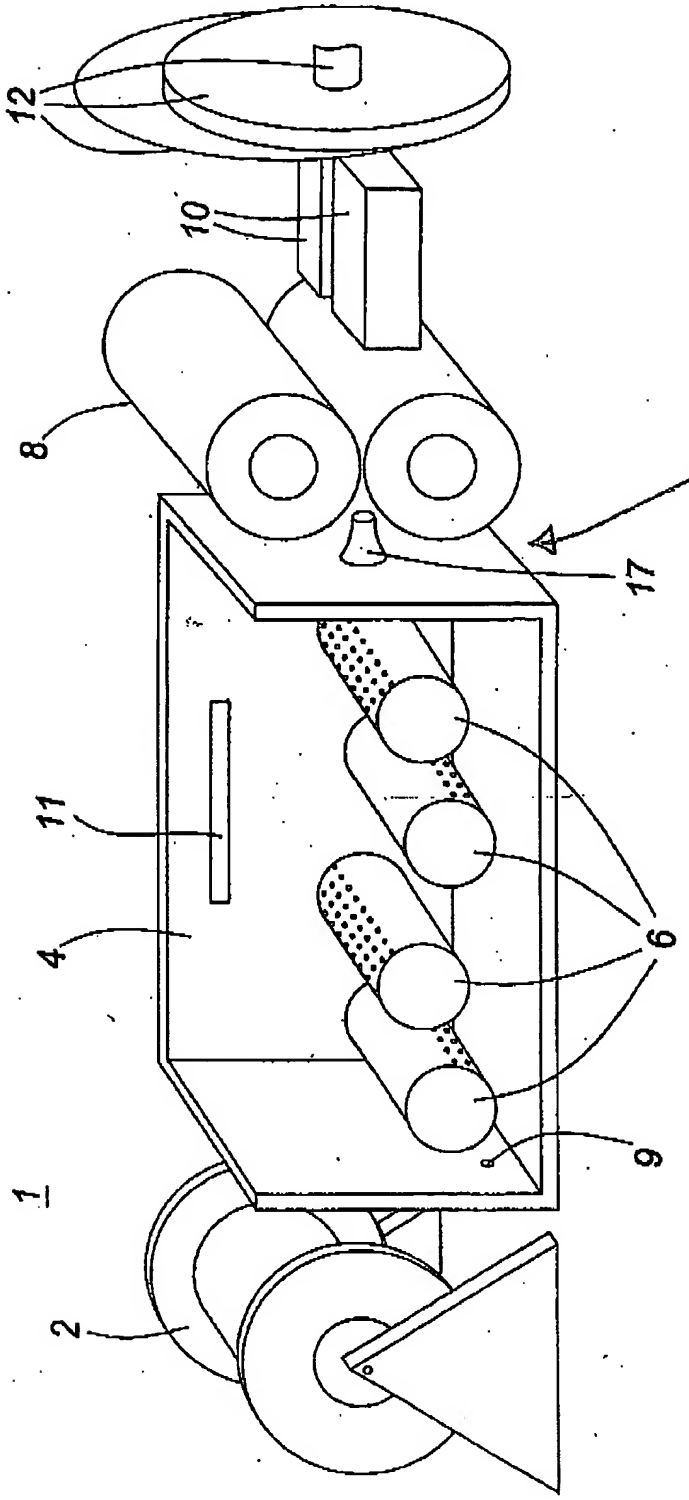

Elements 24 and 25 added

FIG. 1

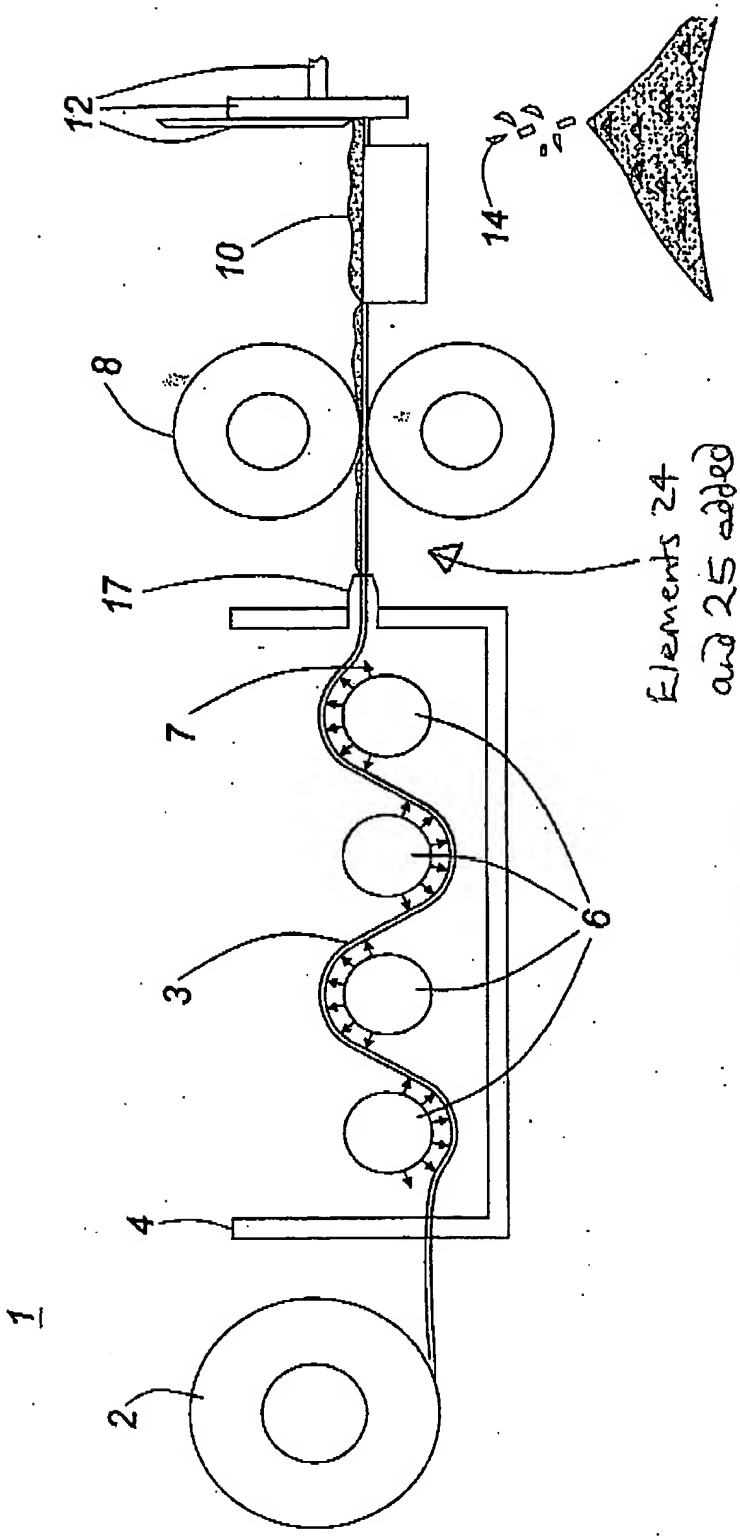

FIG. 2A

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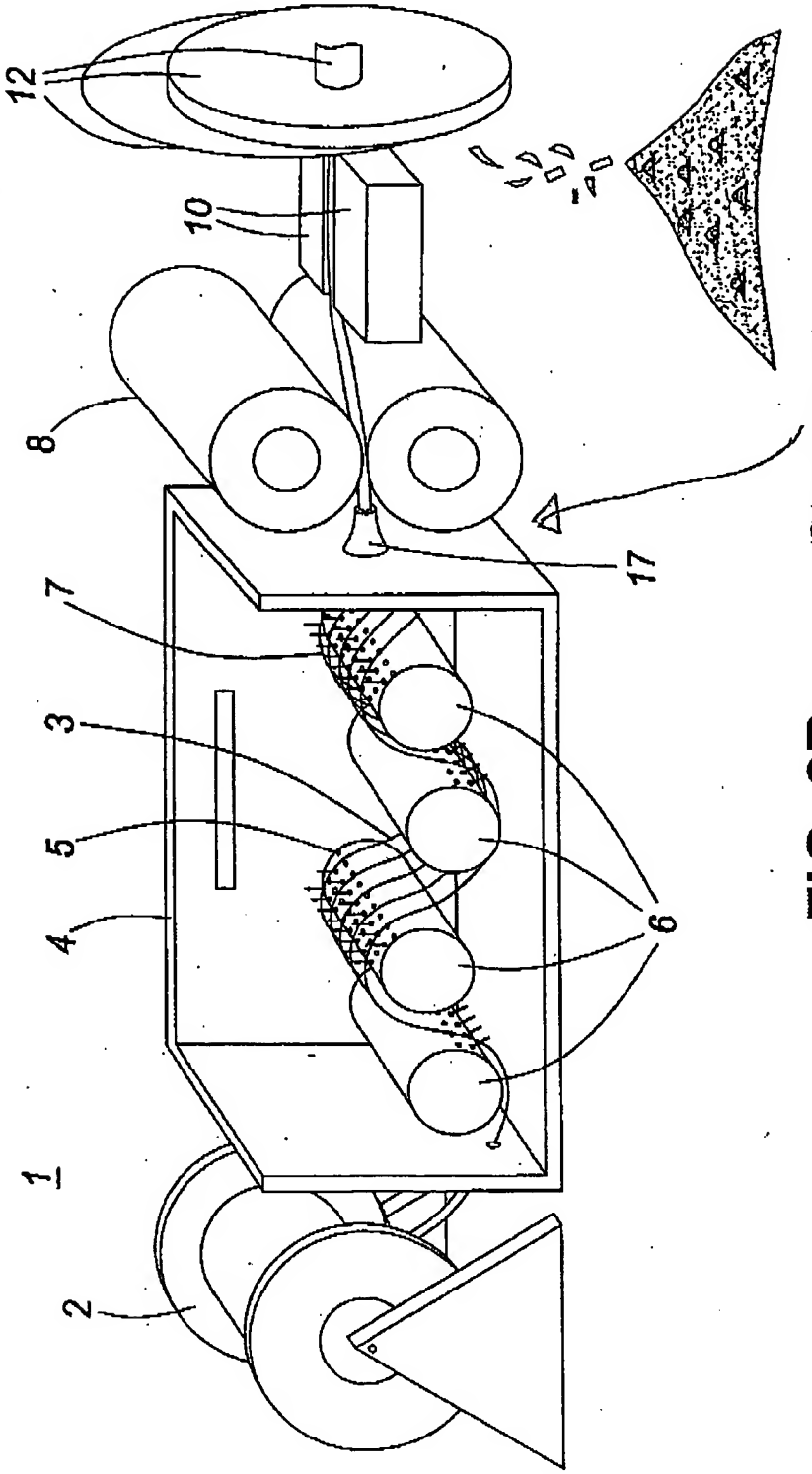

FIG. 2B

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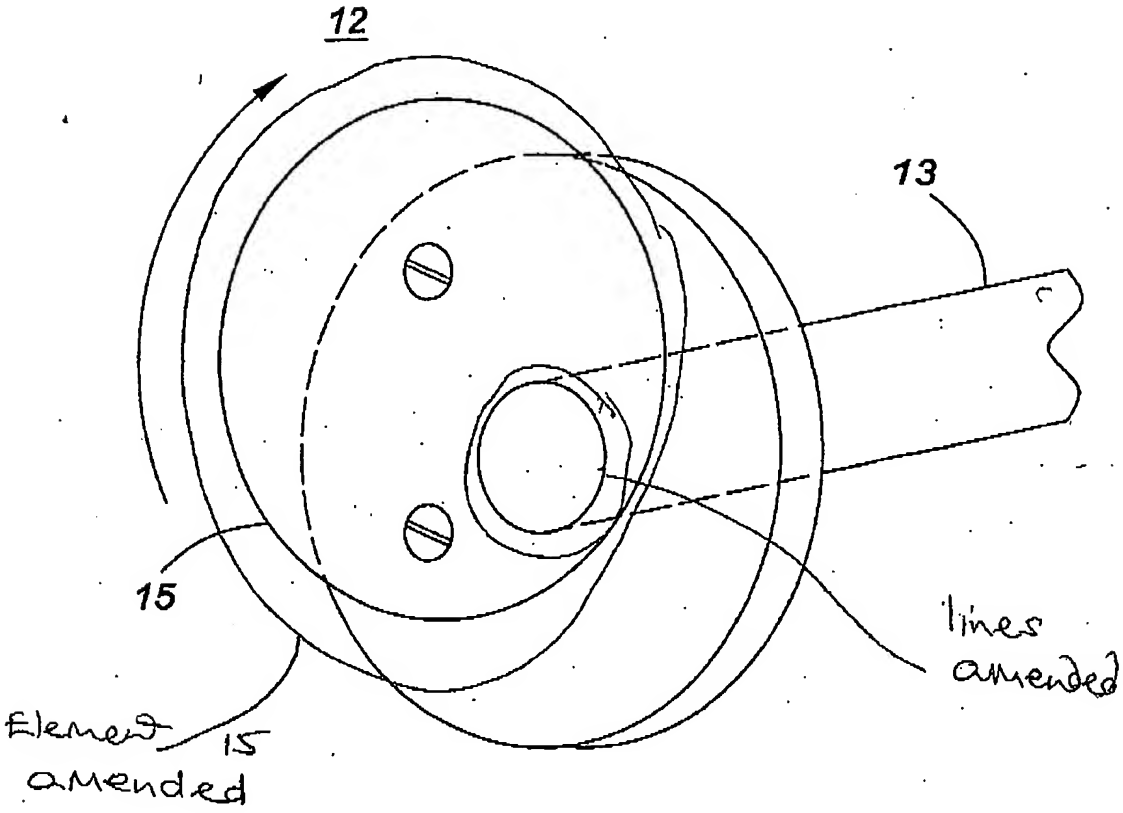

FIG. 5

(19) FEDERAL REPUBLIC OF GERMANY

(12) **Laid-Open Specification**

(11) **DE 35 38 014 A1**

(51) Int.Cl.[4]:
E 01 D 11/00
E 04 H 12/20
D 07 B 7/14
B 63 B 21/20

(21) File No.: P 35 38 014.4

(22) Filing date: October 25, 1985

(43) Date laid open: June 11, 1987

GERMAN PATENT OFFICE

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(61) Addition to: P 34 24 051.9

(72) Inventor:

Inventor will be named later.

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(54) Method for applying a corrosion protection to parallel wire bundles

The method characterized by Patent No. 32 24 051 was developed further, in which operations are largely moved to regional workshops for producing parallel wire and stranded wire bundles which are often used instead of wire cables to accommodate larger loads in technical practice and only the steps absolutely required at the installation site are carried out on site together with the corrosion protection inside the suspension bridge cables and inclined cables. In the course of an additional application to the aforementioned patent, the grant of which was decided on August 26, 1985, a method according to the invention was made available with which an outer protective film with high stability, which is effectively suitable for the inner corrosion protection of the cable, is sprayed on before and also after installation in such a way that a unit is produced by fusion between the thermoplastic material used on the inside and outside. An alternative to the proposed method is used to regenerate the outer protective sheath that has already existed for some time and the cables exposed to UV rays or to be able to reinforce it by a new coating of the same material while avoiding an installation, without producing adhesion problems between the layers of thermoplastic material fused together.

Patent Claims

1. A method for applying a corrosion protection to parallel wire bundles to absorb large loads, in particular for cable-spanned bridges, to stay masts, for structures of offshore technology and the like, whereby the parallel wire bundles are joined together in larger cable cross sections either individually or according to the respective application, wherein a plurality of equally long individual wires are provided in the factory with anchor heads at both ends, coated with plastic, joined to form a parallel wire bundle and connected to form a parallel wire bundle, and in which wires coated with a layer of thermoplastic material are used and the following procedural steps are carried out on site in a continuous uniform operation:
all wires for a parallel wire bundle are simultaneously unwound from a drum in an orderly fashion while avoiding reciprocal longitudinal displacements; all of the wires for a parallel wire bundle are simultaneously heated to a temperature at which the plastic softens; all of the wires for a parallel wire bundle are fed to a press in a predetermined order corresponding to the desired form of the parallel wire bundle; the wires are pressed together in the heated state in the aforementioned order, so that the plastic penetrates essentially completely into the cavities between the wires and thereby fills them and, at the same time, binds the wires firmly together. The parallel wire bundles thus formed are cooled, so that the hardened plastic ensures the inherent stability and thus the desired cross-sectional shape of the parallel wire bundle according to the German Patent 34 24 051, **characterized in that**, after cooling - above all inside the

bundles - the following steps are carried out in a continuous operation by means of a closed device, namely a coating cage:

1.1 Concise local heating of the wires belonging to the peripheral zone of the bundle and of the plastic filling the gussets there on the peripheral zone of the bundle by a revolving mount of flame guns just up to a temperature at which a reliable adhesion is obtained by fusion with the already existing material in the following operations;

1.2 Spraying a thermoplastic material onto the surface of the bundle in one or also several steps, whereby a plurality of spray nozzles are arranged in an annular fashion about the parallel wire bundle at a suitable distance in such a way that the effective ranges of the individual flame spray guns cover one another quite concisely.

1.3 Further spraying of the respective plastic by further rings of flame spray guns, whereby they are directed into the bisectors of the angles of the spray nozzles provided in the first ring in order to definitely obtain as uniform and well-closed a coating thickness as possible, preferably, the arrangement of rings of flame spray guns shifted toward one another by 2 μm the half angle.

1.4 Spraying cold water taken from a body of water in the vicinity in a subsequent cooling cell via several nozzle scrolls arranged behind one another in order to obtain a quick heat flow and quick hardening of the sheath.

1.5 Pulling off the outwardly cooled wire bundle to protect the plastic layer applied via:

a) the rollers surrounding the wire bundles to a large extent to keep the surface pressure low, whereby, at the start, three rollers supported by springs are joined close to one another to form a unit, or

b) a cooled slide tube coated with teflon and having almost the same diameter.

2. The method according to claim 1, characterized in that, to cool and harden the plastic layer sprayed on from about 120 to 60°C inside a heat insulated cooling cell, compressed air through ventilators or a chemical transferring concentrated cold, e.g. nitrogen or the like, is used, whereby methods such as spraying, whirling about, immersion or the like can be used for an effective heat exchange.

3. The method according to any one of the preceding claims, characterized in that the thermoplastic material is an ethylene vinyl alcohol copolymer.

4. The method according to any one of the preceding claims, characterized in that the plastic contains additional passivating components.

5. The method according to any one of the preceding claims, characterized in that the plastic layer is applied in a thickness of between 400 and 2000 μm, preferably between about 600 and 800 μm.

6. The method according to any one of the preceding claims, characterized by the following variation that the operations described above are carried out with aid of a mobile coating cage which is furnished with rollers pulled down from the upper end to the bottom on the respective already standing inclined cable on which the arrangement of the devices is provided in a reverse sequence, whereby the important accessories such as control panel, acetylene gas, oxygen and compressed air bottles, and plastic powder container, perhaps additional containers with liquid nitrogen, are subsequently added in an accompanying manner by means of a control and repair carriage running on an adjacent inclined cable.

7. The method according to claim 6, characterized in that, in an arrangement of several close parallel inclined cables, the coating cage is supported against the PDB immediately below it by means of rollers attached at the bottom, so that the sagging is reduced and an abrasive contact of the inclined cables is avoided.

8. The method according to claims 6 and 7, characterized in that, during the coating process, as uniform an expansion of the wire bundle as possible is produced with aid of irons of the lead weights suspended on the rollers which correspond to that of the coating cage in such a way that the traction cable of the coating cage controlled with the winches, vertical loads are additionally actuated at the constant distance from half an inclined cable length, as a result of which stress and strain ratios of almost constant size are produced in the inclined cable. This is to result in light compressive stresses after hardening and after removal of the additional loads during receding strain of the PDB in the plastic layer, said compressive stresses counteracting the inclination to break at declining temperatures.

9. The method according to claims 6 to 8, characterized in that the old coating is removed after softening and heating by means of a device also running on rollers from the top to the bottom on the respective inclined cable whose coating is in need of repair, said device supporting a heated peeling ring, preferably made of copper, before the new coating, as claimed above, is applied, whereby the energy source, such as acetylene and oxygen bottles, etc. must follow in the same way as provided for the coating process.

Description

I. PREAMBLE

The present invention relates to an improvement or a further development of the method according to German Patent 34 24 051, to which the present patent application is in an additional relationship. Reference is made to the description of said German patent in all points, without repeating said contents in this case.

II. DESCRIPTION

II.1 The subject matter of the main patent is a method according to the preamble of the present claim 1 which is distinguished by an especially rational manufacturing mode of individual parallel wire bundles of various thicknesses and an especially good inner corrosion protection.

In spite of these excellent properties, an additional corrosion protection on the surface of the individual parallel wire bundles is desirable for certain applications, especially when they must alone carry out (unlike in suspension bridges) the function of inclined cables in the various types of applications generally indicated in claim 1.

The object of the present invention is to propose a corrosion protection of this type for practical handling and to also provide the installation steps of the inclined cable suitable therefor. For the latter, a decision must be made as to whether
a) the corrosion protection should be applied to the horizontal parallel wire bundle in the vicinity of the point of installation

prior to the actual assembly of the inclined cable,
b) or whether this should be done after installation of the wire bundle on the existing inclined cable, which could be required especially for repair purposes.

The fact that parallel wire bundles (PDP) and parallel strand bundles (PLB) offer mechanical and thus economic advantages compared to stranded wires (twisted cables and completely or partially closed cables) used almost without exception at home and abroad is known. Transporting factory-produced PDB to the building site and producing a permanently effective corrosiion protection offers certain difficulties when winding the parallel wires on a drum, however, it was possible to overcome these difficulties during the last decades by new developments. Binding the wires prepared appropriately in the factory, which has been made possible in the interim, at the building site by inductive heating and specific compression of the wires to form hexagonal PDB and the binding them in the same operation on site as per the method according to the German Patent 34 24 051 can also be partially used for the inclined cables of various structures. However, while the cross sections of such PDBs are upwardly limited in suspension bridges in view of the high transport weight required by the large length, restrictions of this type are almost eliminated when using such PDB for the substantially shorter inclined cables.

The permissible stresses of cables are, at maximum, to permissible P = 6.46 MN at a ⌀ of 123 mm.

In these strong cables, the outer Z-type wires spring out of the cable composite to an intolerable extent during winding for transport purposes. It is common practice to wind them in again with a copper hammer after installation, the wire surface being primarily damaged, especially when it has a zinc layer for the

purpose of protecting against corrosion.

It is recommended that diameters of more than 100 mm be avoided in fully closed cables, with which there should still be a reliable attainable value for permissible P at 4.5 MN.

The cross-sectional limitations required by such influences do not exist in the PDB or PLB. Transport can be undertaken without difficulty and without any disadvantageous affect to the wire surface by means of the newly developed winding method - US Patent 3,919,762 of November 18, 1975 - by fanning out the bundle and arranging the wires in a layer tightly adjacent to one another, which is especially important when the wires have a plastic layer, preferably levasint, applied in the sintering process in the factory.

The following table indicates the possibilities of obtaining such PDBs with wires ⌀ 7 mm according to the selected number of wires and the resultant permissible load capacities, whereby nowadays permissible tractive forces of up to 10 MN permissible stress are strived for in bridge building practice.

Load Capacity for ST		N/mm² 1400/1600	1500/1700
calc. Breaking load	= 10^{-6} x	A [mm²] x 1600 [MN]	A [mm²] x 1700 [MN]
perm. H	=	0.45 x 1600 [N/mm²]	0.45 x 1700 [N/mm²]
perm. P	= 10^{-6} x	A [mm²] x 720 [MN]	A [mm²] x 765 [MN]

D_e = Diameter of the encasing circle without protective coating calculated

Type	No. of wires	A mm²	D mm²	ST 1400/1600 calc. P MN	ST 1400/1600 perm. P MN	ST 1500/1700 calc. P MN	ST 1500/1700 perm. P MN
1	31	1,192	44	1.91	0.86	2.02	0.91
2	55	2,116.6	50.5	3.39	1.52	3.95	1.62
3	85	3,271	71.15	5.23	2.35	5.56	2.50
4	109	4,194.8	81.1	6.71	3.02	7.13	3.21
5	151	5,811.2	94.4	9.3	4.18	9.88	4.45
6	199	7,658.4	107.9	12.25	5.51	13.02	5.86
7	253	9,736.6	121.6	15.58	7.01	16.55	7.45
8	295	11,353	136.3	18.16	8.17	19.30	8.68
9	349	13,431	147.5	21.48	9.67	22.8	10.3

Essential parallel wire bundle systems between which alternatives are possible within certain limits, are shown in summary in Fig. 1 with the reference numbers 1 to 9.

Wire and stranded wire bundles of this type are bonded together by means of the method described in the main application to form a coherent body in which individual movements are prevented. At the same time, the inclined cable is provided with a dense corrosion protection that is non-corrosive by UV rays by filling all wedge-shaped cavities as a result of heating and compression on the inside.

A long-term test was carried out with a hexagonal bundle treated in this way, said bundle being 13 cm long and consisting of 61 sinter-coated galvanized wires ⌀ 7 mm and after application of a 0.6 mm thick levasint layer, a cross cut being made on one of the hexagonal sides up to the wire surface.

A condensation water test according to DIN 50018, which was converted after 1100 h duration in a salt-spray test according to

DIN 50021, resulted in no deterioration of the adhesion nor in any indication of corrosion on the cut of the test piece after 2833 h.

A further cross cut was made on the other side of the test piece, on which a peeling off of 2 mm each in width could be ascertained after a further 7800 h salt-spray test. A 10 mm long and 4 mm wide corrosion only appeared at the first cross cut after the stress was carried out the longest time (88%) as a salt-spray test after 8929 h. No sodium hydroxide solution and also no peeling off could be found in the first extracted wire layer.

II.2 The inclined cable standing only in the form of a PDB or PLB must, in addition, receive an outer sheathing since the narrow cross sections do not include any reserves, other than in the main cables of suspension bridges, are completely stressed more often and have prolonged fatigue loading fairly often.

To fuse this together with the thermoplastic materials on the inside to form a unit and to thus obtain a complete adhesion of the material, based on comprehensive studies, the application of a thermoplastic layer, i.e. preferably of an ethylene vinyl alcohol copolymer (the material Levasint was studied) was also proposed according to the invention for the outer surface.

The tested flame spraying with appropriately formed flame-spray guns is provided for the application and fusion of this material.

With a maximum wire bundle diameter of about 150 mm and an operationally advantageous nozzle distance from the item of 400 mm, the surrounding metal cage in which all required devices are to be accommodated had to have an outside diameter of about 1470 mm, which requires a transverse distance of the centres of the wire bundles of 850 mm. In this way, the plastic application can be

subsequently carried out in an effective manner between several already existing PDBs. In the event that bundle distances of this type are not quite present on existing structures, the distance of the spray nozzle to the item could be reduced a little with a somewhat lower attainable efficiency. This could be all together 12 guns, about 72 m^2/h with a coating thickness of 0.8 mm with 2 revolving coating mounts with 6 guns each. In continuous operation of the 12 guns, the advancement speed would reach 4.6 m/sec. When using 2 revolving coating mounts, the guns are mutually displaced by half the angle between 2 guns of a revolving mount.

The system consists of the following parts:
within the stationary coating cage:
flame-spray guns, removal by suction with blower and filter, they are shown in Fig. 2,
followed on the outside, housed in or on the control carriage with flexible feed lines and quick-attach couplings, by:
plastic powder receptacle, acetylene, oxygen and compressed air bottle
control mechanism (these devices are not shown here, see brochures of the manufacturing firm for flame-spraying systems E. R. Stüwe, D-5802 Wetter-Albringshausen).

Fig. 2 shows:
Fig. 2.1 the application cell
Fig. 2.2 the cooling cell to obtain a quick hardening of the coating sprayed on
Fig. 3 section I-I
Fig. 4 section II-II
Fig. 5 section III-III
Fig. 6 surface pressure reducing storage of the PDB after coating

Reference Numbers:

10 Parallel wire and stranded wire bundles (PDB and PLB), first, these bundles are pressed together after heating, as described, and all cavities thereby filled with thermoplastic material

11 Flame-spray guns

12 Guns only for heating the PDB and PLB 2 revolving mounts with 6 guns each Fig. 3 and Fig. 4

13 Flexible line to the control panel
to the powder receptacle
to the compressed air bottle - transport, whirling, cooling process -
to the acetylene bottle
to the oxygen cylinder

The materials and devices are located outside of the coating cage.

14 Levasint layer sprayed onto the outer surface of the PBD d = 400 - 1500 µm (the optimum is currently being determined by tests and will be inserted in a supplemental application)

15 Anchor button - bundle end - can be pushed through device.

16 attached guide rail for passing the anchor through

17 supply line for cooling water

18 spray sectors

19 directed water jet

20 water outlet trough

21 sheathing metal consisting of light metal for the coating cage - two-piece for inserting the PDB prior to start of the coating, screwed together by means of lateral flanges

22 revolving rubber sealing mounts and gaskets consisting of non-flammable material

23 group of three teflon-coated bearing pulleys

24 suctioning the application cell off with filter and blower

25 automatically magneto-inductively operating layer thickness gauge according to DIN 50 981/82 with indicator and stop device, in the event that it deviates from the set tolerances.

26 The roller axes are flexibly mounted by means of springs to reduce the surface pressure on the applied levasint layer.

Fig. 7 Longitudinal section through a mobile coating cage which is fed by a small projecting support structure attached to the upper pylon end and moved lengthwise from there on the PDB by rollers, whereby the coating of an inclined cable in need of repair takes place.

Fig. 7.1 Application cell advancing speed being reduced to about 2 cm/sec in the interest of an intensive cooling, consequently, only one revolving mount of spray guns is required. In the event that space between the inclined cables is narrow, the effective distance between guns and PDB can be reduced to 350 mm, since the flame can be flexibly regulated. To obtain sufficient cover at the seam of the spraying areas, at least 2.5 cm, the number of guns in the revolving mount must perhaps be increased, for which the advice of the designated specialist is required. It is useful to only heat the outer peripheral zones of the PDB for a short time to obtain a good material adhesion, in order to keep the heat absorption inside the bundles as low as possible.

Fig. 7.2 The cooling cell is covered on the inside walls with a heat insulation consisting of glass fibre or similar material 17 when distance must be taken from a water-spray cooling due to supply difficulties. The thermoplastic layer must be cooled down from 120°C to 50°C in a relatively quick manner, so that the heating

process has progressed to such an extent that the surface pressure cannot cause any damage on the spring-mounted roller bearing. Two cooling factors are effective:
a) equalizing heat with the interior area of the PDB having a normal temperature
b) the concentrated blowing with 4 strong ventilators having 8 KW in total
With the preferred reduced operating speed of V = 2 cm/sec = 72 cm/h are available in the example shown in Fig. 7 for the cooling process a 80 sec and b 60 sec which, according to calculations, is sufficient.

Fig. 8 section A-A with a view on the cooling cell

Fig. 9 section B-B with a view onto the application cell, only a flame ring 12 acting briefly on the outer surface for fusion and a flame spray ring with 7 guns 11.

Reference Numbers

The same explanations as for Figs. 2 to 6, namely for 10 to 15 and 21 to 25 apply, reference number 20 is omitted.

16 For compressors with blower, output about 4 x 1.5 = 6 m^3/sec at 8000 N/mm^2 pressure. Power supply through a flexible cable which is unrolled from the pylon top and taken along by means of rollers at the PDB 10.

17 isulating the cooling cell against penetrating heat from the application cell

18 guide plates for the air current, directed in a concentrated manner on the PDB 10!

19 cConcentrated and directed air current to the cooling for the coating.

23 Flexibly mounted roller bearing, provided in at least two vertical planes.

Fig. 10 Bracing the mobile coating cage moving along the PDB against an adjacent PDB below it to reduce sagging and prevent mutual damages. Roller movement 27 which is attached below the coating cage according to Fig. 1 in such a way that a part of the weight generating a passage on a PDB situated below it and perhaps in the cable composite with a certain distance (e.g. an average distance of 850 mm is here assumed) is also carried away. Equivalently, a solution may also be produced by means of which the weight of a coating cage is suspended on the next higher PDB to reduce the degree of sagging.

Fig. 11 A system for regulating the longitudinal load of the inclined cable during the coating with the objective of producing an almost constant pre-expansion during this process and to thus introduce a compressive stress into the hardening plastic layer. Two bodies of iron or lead, which have almost the same weight as the coating cage, are used for this purpose and, under condition 1: weight G1, is half the length of a inclined cable ahead on the winch-controlled cable 28.

Fig. 12 29 under condition 2: weight G II half the length of the inclined cable are led behind the coating cage.

The tractive power in the PDB S

$$\frac{P \cdot l}{4 \cdot g}$$

is almost constant by taking along the two weights GI to GII at the distance of half of the inclined cable length; wherein:
l = inclined cable length

f = passage
P = sum of the load components each acting at a right angle to the inclined cable

The weight GII cannot be removed until the appied plastic layer has hardened completely and the longitudinal strain on the PDB has in this way been offset.

II.3 It is pointed out as disadvantageous that, in favour of the flexible cable vis-à-vis the parallel wire and stranded wire bundles, the installation of such inclined cables is made more difficult when the cavities are filled with a plastic on the inside and the wires bonded or when they have previously received an almost rigid outer cover. However, these are all processes which are absolutely necessary in the interest of a reliable corrosion protection. One could contemplate carrying out the heating of the wires coated by the sintering process in the factory, such as the compression of the bundles and their outer coating according to the above described method, on the stationary inclined cable after it has previously been installed in the flexible state. However, the great weight of the devices required for the heating and compression, which would quite strongly stress the taut inclined cables almost diagonally to the direction of pull speaks against this. Moreover, the structural quality and accordingly the quality of the inner corrosion protection would thereby be difficult to monitor, for which reason the operations should advantageously take place prior to installation.

To this end, two methods have already been practically tested which greatly facilitate and economically design the raising and fixing of the individual reinforced PDBs, which can only be bent very little during installation, by means of specially developed devices, see the publication Rademacher, C.-H.: *Nordbrücke*

Mannheim-Ludwigshafen, Werkstattfertigung und Montage, Stahlbau 19, No. 6, pp. 164 to 165 and *Berichte über den Bau der Schrägkabelbrücke 1977* over the Parana at Los Palmas in Argentina.

The most important objects can be found in the description of Fig. 13:

Fig. 13 shows the possibilities, due to the bonding and coating of the wires, to be able to economically install the relatively stiff inclined cables by a device without damage, whereby the dimensions of the inclined cable bridge over the Rhine between Mannheim and Ludwigshafen can be used as an example.

In the sections I to the right of the pylons and II on the left of the pylons, this figure shows the principle of the two different methods commonly used nowadays, with which the wire bundles reinforced on the inside by bonding or pulling on a cover can be mounted. It is thereby important that a curvature 1/R, which adequate for the moment of inertia of the reinforced PDP, is not fallen below with these methods during installation, at 349 wires ø 7 mm R65 m.

In section I, the PDB 10 can be pulled into the desired position almost parallel to the auxiliary cable on a tightened auxiliary cable 30 with aid of a moving device 31 which is clamped on a tractive cable at distances that take the sagging of the PDB into consideration, if there is sufficient space for spreading out and cooling the PDBs between the PDB unwinding and treatment position 32 up to the start of the curvature template 33. In this case, the PDB 10, as soon as it has passed the wooden diagonally shiftable curvature template 33 having the minimum radius of curvature at the start of the inclined path 30, the PDB is surrounded by rubber-lined clamp straps 34 and suspended on the moving device 31 by

means of short suspension cables 35. The distance of these holding devices must be selected such that critical saggings can be reliably prevented.

A transversely movable support frame 36 which carries the auxiliary cables 30 and the rollers for the tension and lifting devices, is mounted on the respective pylons in a light steel construction. These various tension cables 40 (not all are shown in detail) are controlled by a winch battery 41 which is situated in the vicinity of the pylons on the bridge deck.

Since the section II of the bridge, suspended on the inclined cables, is freely built in front - the projecting structure has shown to be an economic design - there is no possibility at this end to tighten an auxiliary cable 30 against a bridge girder part far enough in front. Rather, it must be fastened to the projecting derrick 37 with a greater sagging and an appropriately lesser longitudinal feed. There is also no possibility to lay the PDBs straight to be pulled up in a straight position in front of a rising inclined cable in section II on the bridge deck. The head of the respective PDB can, at best, be placed over the already projected section in one shot road construction 38 which hangs on the projecting derrick and are held back in a necessary manner by means of a roller and winch 39.

In section II, the DPB 10 to be mounted must be turned about the left end point in as flat a position as possible, assisted by the aforementioned gradually declining backstay by the cable lines 40 which hang on the moving devices 31, and which are pulled up diagonally in the pylon area. In this manner, the PDB can be brought into the required position, completely flat, by the electronically controlled winch battery 41 with adequate slackening of the backstay 39. The moving devices 31 make it possible to move

the raised PDB back and forth as inclined cables slightly by means of the winches and special tension cables and to thus insert the anchor heads into the anchor recesses on the pylon and bridge girder.

The processes indicated here represent various improvements of methods which have already been used in practice. It would be desirable if it were ensured by appropriate organizational steps and the type of orders granted that the devices required for these operations could be used more often for economic reasons.

The method which was shown for the side II is protected by the German Patent No. 21 03 192.5, for which the applicant in this case possesses a transferrable right of joint use. With the aid of this method, the technical difficulties which previously hindered the installation of reinforced inclined cables could be overcome, as the practical embodiment shows.

Fig. 1

(for the most part illegible)

PROPOSAL FOR AN ALMOST ROUND PARALLEL WIRE BUNDLE SYSTEM

Wire gauge d = 7 mm

Diameter D_D of the surrounding circle without thickness of a protective cover calculated

Figs. 2, 3, 4, 5 and 6 - no legend

Figs. 7, 8 and 9 - see page in question

Figs. 10, 11, 12 and 13 - no legend